M.Sc. (Mathematics): 2nd year

Subject: Differential Geometry -II
(w.e.f. session 2016-17)

IIIth Sem.

Subject Code: MT504

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Unit I:
Almost contact manifold, affinely almost co-symplectic manifold, contact metric structures, para-contact structures.

Unit II:
Almost complex manifold, Nijenhuis tensor, contravariant & covariant almost analytic vector, F-connection, linear connexion.

Unit III:
Kahler & nearly Kahler manifolds, affine connections, curvature tensors, CR-submanifolds of Kahlerian manifolds.

Unit IV:
Sasakian manifold, quasi sasakian manifold, k-contact Riemannian manifold, semi-invariant submanifolds of sasakian manifold.

Unit V:
Almost Hermite manifolds, submanifolds of almost hermite manifold, almost grayan submanifold, F-structure manifolds.

Text Books:

2. Lecture notes on differentiable manifolds, S.I.Hussain.
# Applied Functional Analysis

**Subject Code:** MT505  
(w. e. f. session 2016-17)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Metric Spaces</td>
<td>Metric spaces, examples of metric spaces, interior point, limit point, open set, closed set, neighborhood, convergence, Cauchy sequence, continuity, complete metric spaces, compact metric spaces.</td>
</tr>
<tr>
<td>2</td>
<td>Normed Spaces &amp; Banach spaces</td>
<td>Normed linear space, Banach spaces, incomplete normed spaces, finite dimensional normed spaces and subspaces, equivalent norms, compactness, Riesz’s lemma, linear operators, bounded and continuous linear operators, continuity of linear operators, linear functional, linear operators and functional on finite dimensional spaces.</td>
</tr>
<tr>
<td>4</td>
<td>Fundamental Theorems of Normed and Banach spaces</td>
<td>Zorn’s lemma, Hahn–Banach theorem, Hahn Banach theorem for complex vector spaces and normed spaces, Application to bounded linear functionals on $C[a,b]$, uniform boundedness theorem, Open mappings, open mapping theorem, Closed linear operators, closed graph theorem.</td>
</tr>
<tr>
<td>5</td>
<td>Banach fixed point theorem</td>
<td>Contraction mappings, Picard’s iterates, Banach fixed point theorem, Application of Banach theorem to linear equations, Application of Banach theorem to differential equations.</td>
</tr>
</tbody>
</table>

**Text book:**

**Reference books:**
M.Sc. (Mathematics): 2nd year

Subject: Integral Equations

(w.e.f. session 2016-17)

Subject Code: MT506

IIIrd Sem.

UNIT 1: Fredholm and Volterra integral equation

Regularity conditions, special kinds of kernels, Eigen values and Eigen functions,
Convolution integral, reduction to a system of algebraic equations, Fredholm alternative, an
approximate method, examples, iterative scheme, Volterra integral equation, Some results
about the resolvent Kernel, Examples.

UNIT 2: Classical Fredholm Theory

The method of solution of Fredholm, Fredholm first theory, Examples.

UNIT 3: Applications to ordinary differential equations

Initial value problems, boundary value problems, Dirac delta Function, Green’s Function
approach, Green’s function for n^th order ordinary differential equations, Modified Green’s
function, Examples.

UNIT 4: Symmetric Kernels

Introduction, Fundamental properties of Eigen values and Eigen functions for symmetric
Kernels, Expansion in Eigen functions and Bilinear forms, Hilbert-Schmidt theorem and
some immediate consequences, solutions of a symmetric integral equation, Examples.

UNIT 5: Singular Integral Equations and Integral Transform methods

Abel’s Equations, Inversion formula for singular integral equations, Laplace transform,
Application to Volterra integral and integral differential equations with convolution type Kernels,
Abel’s Integral equations, Fourier Transform, Solution by Fourier Transform Method.

Reference Books

Integral University, Lucknow
Department of Mathematics

M.Sc. (Mathematics): 2nd year

Subject: Optimization Techniques
(w.e.f. session 2016-17)

Subject Code: MT507

IIIrd Sem.

UNIT- 1


UNIT- 2


UNIT- 3

Game Theory: Basic definitions, Two-person Zero-sum games, Pure and mixed strategy, Principle of Dominance, Graphical method, Solution of games by linear programming method.

Decision Theory: Introduction, Elements of decision problem, Types of decision making environment, Decision tree.

UNIT- 4

Sequencing: Basic assumptions, Processing of n-Jobs on 2-Machines, n-Jobs on 3-Machines and 2-Jobs on k-Machines.

Replacement Problems: Replacement of items that deteriorate with time, Replacement of items that fails suddenly - Individual replacement policy and Group replacement policy.

UNIT- 5

Inventory Models: Types of inventory models, Various inventory costs, Deterministic inventory models, Economic order quantity, Price breaks- one, two, n-price breaks, Single period probabilistic inventory models.

REFERENCES
Unit 1  

Unit 2  
Two dimensional irrotational motion produced by motion of Circular, Co-axial and elliptic cylinders in an infinite mass of liquid-Theorem of Blasius motion of a sphere through a liquid at rest at infinity-Liquid streaming past a fixed sphere.

Unit 3  
Fundamental Equations of Motion of Viscous Fluid; Equation of State, Equation of Continuity, Navier-Stokes (NS) Equations (equation of Motion, Equation of Energy, Streamlines & Pathlines, Vorticity and Circulation (Kelvin's Circulation Theorem).

Unit 4  
Dynamical Similarity (Reynold's Law), Inspection Analysis-Dimensional Analysis, Buckingham-π-Theorem, and its Applications π-products and coefficients, Non-dimensional parameters and their physical importance. Exact Solutions of the N S Equations.

Unit 5  

Text Books  

Reference Books  
3. T. E. Faber, Fluid Dynamics for Physicists, Cambridge University Press.
Integral University, Lucknow  
Department of Mathematics

M.Sc. (Mathematics): 2nd year  

Subject: Special Function and Orthogonal Polynomials  
(w.e.f. session 2016-17)  

IIIrd Sem.  

Subject Code: MT509  

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Unit I  
**Gamma and Beta Functions:**  
The Euler or Mascheroni Constant $\gamma$, Gamma Function, A series for $\Gamma'(z)/\Gamma(z)$, Difference equation $\Gamma(z+1) = z\Gamma(z)$, Euler's integral for $\Gamma(z)$, Beta function, value of $\Gamma(z)\Gamma(1-z)$, Factorial Function, Legendre's duplication formula, Gauss multiplication theorem.

Unit - II  
**Hypergoemetric and Generalized Hypergeometric Functions:**  
Definition and integral representation of Gauss hypergeometric function $2F_1(a,b;c;z)$  
Contiguous function relations, Hypergeometric differential equation and its solutions, $F(a,b;c;z)$ as function of its parameters, Elementary series manipulations, Simple transformations and reduction formulas.

Unit-III  
**Bessel functions and Legendre Polynomials:**  
Definition of $J_n(z)$, Bessel's differential equation, Generating function, recurrence relations and integral representation, Generating function for Legendre polynomials, Rodrigue's formula, Recurrence relations, Hypergeometric forms of $P_n(x)$, Laplace's first and second integral forms, Orthogonality.

Unit-IV  
**Hermite Polynomials:**  
Definition of Hermite polynomials $H_n(x)$, Pure and differential recurrence relations, Rodrigue's formula, Other generating functions, Orthogonality, Expansion of polynomials.

Unit-V  
**Laguerre Polynomials:**  
The Laguerre Polynomials $L_n(x)$, Generating functions, Pure and differential recurrence relations, Rodrigue's formula, Orthogonality, Expansion of polynomials.

Books Recommended

Integral University, Lucknow
Department of Mathematics

M.Sc. (Mathematics): 2nd year
Subject: Mechanics
(w.e.f. session 2016-17)

Subject Code: MT510

IVth Sem.

UNIT-1
General force system, equipollent force system, equilibrium conditions, Reduction of force systems, couples, moments and wrenches, Necessary and sufficient conditions of rigid bodies, General motion of rigidbody, Moments and products of inertia and their properties, Momental ellipse, Kinetic energy and angular motion of rigid bodies.

UNIT-2
Moving frames of references and frames in general motion, Euler’s dynamical equations, Motion of a rigid body with a fixed point under no force, Method of pointset Constraints, Generalized coordinates, D’Alembert’s principle and Lagrange’s equations, Applications of Lagrangian formulation.

UNIT-3
Euler’s equation for functional containing first order derivatives and one independent variable, extremals, functional dependent on higher order derivatives, Functional dependent on more than one independent variable, variational problems in parametric forms

UNIT-4
Functional dependent on one and two functions, One sided variations, Jacobian and Legendre conditions, second variations, variation principle of least action

UNIT-5
Hamilton’s principle, Cyclic coordinates and conservation theorems, Canonical equations of Hamilton, Hamilton’s equations from variation principle, Principle of least action.

Books Recommended:

Integral University, Lucknow
Department of Mathematics

M.Sc. (Mathematics): 2\textsuperscript{nd} year

Subject: Advanced Functional Analysis
(w. e. f. session 2016-17)

Subject Code: MT511

IV\textsuperscript{th} Sem.

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</table>

Unit – 1

Operators and Reflexive spaces
Hilbert–Adjoint operator, self adjoint, Unitary and normal operators, adjoint operator, Dual spaces, reflexive spaces, strong and weak convergence, convergence of sequence of operators and functional.

Unit – 2

Spectral Theory of Linear Operators in Normed Spaces.

Unit – 3

Compact linear Operators on Normed spaces and Their Spectrum.
Compact Linear Operator on Normed Spaces, Properties of Compact Linear Operator, Spectral Properties of Compact Linear Operators on Normed Spaces, Operator Equations Involving Compact Linear Operators, Further Theorem of Fredholm Type,

Unit – 4

Spectral Theory of Bounded Self – Adjoint Linear Operator.

Unit – 5

Approximation Theory
Strict convexity, uniform convexity, Approximation in Normed Spaces, Existence and Uniqueness, Uniform Approximation, Chebyshev polynomial, Best approximation, approximation in Hilbert space.

Reference books:
Integral University, Lucknow
Department of Mathematics

M.Sc. (Mathematics): 2nd year

Subject: Topology

(w.e.f. session 2016-17)

Subject Code: MT512

UNIT 1
Definition and examples of Topological spaces, closed sets, closure, neighbourhoods, interior, exterior, boundary and accumulation point of a set, derived sets, dense sets, bases and sub bases, relative topology, Subspaces, Finite intersection property.

UNIT 2
Continuous functions and homeomorphism, first and second countable space, Lindelof spaces, separable spaces, The separation axioms-T1, T2, T3, T4 their characterization and basic properties, product topology, metrizability of products of metric spaces, quotient topology, convergence, sequence.

UNIT 3
Compactness, Basic properties of compactness, compactness and finite intersection property, Bolzano-Weierstrass property, sequential compactness, local compactness and one point compactification, connected sets in the real line.

UNIT 4
Connectedness, connected spaces and their properties, local connectedness, path connectedness, components, locally connected spaces Urysohn’s lemma, Teitz extension theorem, paracompactness, characterizations of para compactness in regular spaces.

UNIT 5
Product Topology (finite & infinite), Tychonoff product topology in terms of standard sub base and its characterizations, product topology and separation axioms, connectedness and compactness (including the Tychonoff’s theorem), countability and product spaces.

References
Integral University, Lucknow
Department of Mathematics

M.Sc. (Mathematics): 2nd year

Subject: Magneto Hydrodynamics

(w.e.f. session 2016-17)

Subject Code: MT513

Unit –I
Maxwell’s electromagnetic field equations, Magnetic induction equation and magnetic Reynold’s number, Alfvén’s Theorem and its consequences.
Magneto hydrostatic, Force free magnetic fluids (Basic equations, boundary conditions & magnetic energy).

Unit –II

Unit –III
Thermal Instability; Benard problem, basic hydrodynamical equations, perturbation equations, normal mode analysis, principle of exchange of stabilities, exact solution when instability set in as stationary convection for two free boundaries.

Unit –IV
Instability of inviscid shear flow, physical problem, governing equations: equation of conservation of momentum, the equation of incompressibility and the equation of conservation of mass, initial stationary state solution, perturbation equations.

UNIT-V
Homogeneous & heterogeneous shear flow, normal mode analysis, derivation of Rayleigh equation, Derivation of Taylor Goldstein equation, different form of TG equation using transformations.

Text Book
3. Advanced Fluid Dynamics by Murlidhar and Biswas.

Reference Books:
UNIT-I:


UNIT-II:

Mathematical Modelling through difference equations: Mathematical modelling through difference equations, some simple models Basic theory of linear difference equations with constant coefficient. Mathematical Modelling through difference equations in economics and finance.

UNIT-III:

Mathematical Modelling through difference equations (contd.): Mathematical modelling through difference equations in population dynamics and genetics. Mathematical Modelling through difference equations in probability theory. Miscellaneous examples of Mathematical modelling through difference equations.

UNIT-IV:

Mathematical modelling through Graphs: Situations that can be modelled through graphs - Mathematical models in terms of weighted graph.

UNIT-V:

Mathematical Modelling through calculus of Variations and Dynamic Programming: Optimization principles and techniques -Mathematical modelling through calculus of variations- Mathematical Modelling through dynamic programming.

Recommended Text:

Reference Books:
5. D. N. Burghes, Modelling with Difference Equations, Ellis Harwood and John.
Integral University, Lucknow  
Department of Mathematics  

M.Sc. (Mathematics): 2nd year  

IVth Sem.  

Subject: Calculus of Variations  
(w.e.f. session 2016-17)  

Subject Code: MT515  

UNIT 1:  
Definitions of functional, Strong and weak variations, Derivations of Euler's Equation, Other forms of Euler's Equation, Special Cases, Examples, Fundamental Lemma of Calculus of Variations.  

UNIT 2:  
The problem of Minimum surface of revolution, Minimum energy problem, Brachistochrone Problem, Variational Notation, Variational Problems involving several functions.  

UNIT 3:  

UNIT 4:  
Variation of functional, Euler-Lagranges equation, Necessary and sufficient conditions for extrema, Variational methods for boundary problems in ordinary and partial differential equations.  

UNIT 5:  
Application of Calculus of Variation, Hamilton's Principle, Lagrange's Equation, Hamilton's Equation. Variational Problems with Movable boundaries, Simplest problem with movable boundaries, Examples, Problems with movable boundaries for functional of the form $\int_{x_0}^{x_1} (x,y,z,y',z') \, dx$ and $\int_{x_0}^{x_1} (x,y,y',y'') \, dx$, Examples.

Reference Books:  